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DETAILED ANALYSIS OF ALTERNATIVES FOR OPERABLE UNIT 4 TASK 13 PRESENTATION JULY 1990

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PRESENTATION

DETAILED ANALYSIS OF ALTERNATIVES FOR OPERABLE UNIT 4

TASK 13 PRESENTATION

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

REMEDIAL INVESTIGATION and FEASIBILITY STUDY

July 1990

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

DRAFT

REMEDIAL INVESTIGATION
AND
FEASIBILITY STUDY

FEED MATERIALS PRODUCTION CENTER

FERNALD, OHIO

FMPC TASK 13 PRESENTATION
DETAILED ANALYSIS OF ALTERNATIVES
FOR OPERABLE UNIT 4

Prepared by

Advanced Sciences, Inc.
International Technology Corporation

July 1990

INTRODUCTION & AGENDA

- Operable Unit 4 Definition
- Remedial Action Objectives
- ARARs
- Description of Alternatives
- Evaluation of Alternatives Versus Criteria

OPERABLE UNIT 4 DEFINITION

AND

TASK 13 ACTIVITIES

RI/FS TASK 13
DETAILED ANALYSIS OF THE ALTERNATIVES

- Alternatives Were Developed and Screened in Task 12
- Further Definition of Alternatives in Task 13
- Analyzed Against Evaluation Criteria

OPERABLE UNIT 4

- Silos 1 and 2 (K-65)
- Silo 3 (Metal Oxide)
- Silo 4 (Never Used)
- Berm Around Silos 1 and 2
- Contaminated Soil Immediately Below Silos (Excluding Aquifer)

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REMEDIAL ACTION OBJECTIVES

AND

ARARS

GENERAL REMEDIAL ACTION OBJECTIVES FOR OPERABLE UNIT 4

- Prevent Release of Radon Gas from Wastes
- Prevent Migration of Contaminants to Environmental Media that Exceed Public Health or Environmental Standards
- Prevent Direct Contact with Contaminated Structures
- Correct Structural Conditions that Could Lead to Sudden Releases of Chemicals or Radionuclides

Identification of Potential ARARs and TBCs

Appendix A - Operable Unit 4, Task 12 Report

Chemical, Action, and Location Specific ARARs

Applicable, Relevant, and Appropriate, and TBCs

Chem, Action, Loc	Standard	ARAR/TBC	Regulation	Alternative
Radionuclide Emissions (Except Airborne Rn-222)	Public Dose < 10 mrem/yr	Applicable	40CFR61, Subpart H	All
Radon-222 Emissions	No Source > 20 pCi/sq.m.-s	Applicable	40CFR61, Subpart Q	All
Radioactive Materials in the Ohio River and in Receiving Waters Outside the Mixing Zone	Gross Alpha < 15 pCi/l (exluding Rn and U) Ra-226 + Ra-228 < 5 pCi/l Gross Beta < 50 pCi/l Tritium < 20,000 pCi/l Strontium-90 < 8 pCi/l	Applicable	OAC3745-1-32(c)(9)	All
Radiation Doses, Levels, and Concentrations	As specified in regulations	Relevant and Appropriate	10CFR20.101-20.106 OAC3701-38	All
Radionuclides in Drinking Water	Ra-226 + Ra-228 < 5 pCi/l Gross Alpha < 15 pCi/l (excluding Rn and U) Beta + Gamma Dose < 4 mrem	Relevant and Appropriate	40CFR141.15-141.16 OAC3745-81-15 to 16	All
Residual Radioactive Material	Control shall be effective for 200 to 1000 years Rn-222 releases < 20 pCi/sq.m.-s (to atmosphere) Increase of Rn-222 < 0.5 pCi/l-yr	Relevant and Appropriate	40CFR192, Subparts A,C	All
Chemicals or Radionuclides in Drinking Waters	Arsenic < 0.05 mg/l Barium < 1.00 mg/l Cadmium < 0.01 mg/l Chromium < 0.05 mg/l Lead < 0.05 mg/l Mercury < 0.002 mg/l Nitrate < 10.0 mg/l Selenium < 0.01 mg/l Silver < 0.05 mg/l	Relevant and Appropriate	40CFR141.11 OAC3745-81-11	All

Chem, Action, Loc	Standard	ARAR/TBC	Regulation	Alternative
Radiation Dose Limits (All Pathways)	Public Dose < 100 mrem/yr Drinking Water Dose < 4 mrem/yr	To Be Considered	DOE Order 5400.5	All
Radiation Protection of Individuals	As Specified in DOE Order 5480.11	To Be Considered	DOE Order 5480.11	All
Area Affecting Stream or River	Avoid Impacts to Wetlands Protect Fish and Wildlife	Applicable	40CFR6.302(a) 40CFR6.302(g)	1, 2
Protection of Wetlands	Construction Restrictions	To Be Considered	Executive Order 11990	All
Flood Plain Management	Construction Restrictions	To Be Considered	Executive Order 11988	All
Discharge of Treatment System Effluent	Monitoring Requirements, (Mass, Volume, Frequency) Approved Testing and Analytical, and Minimization of Impacts Best Available Technology Water Quality Standards	Applicable	40CFR136.1-136.4 40CFR122.44 40CFR122.41 OAC3745-33-04 OAC3745-33-05	1, 2, 3, 4, 6, 7, 8, 9
Discharge of Treatment System Effluent	Best Management Practices	Relevant and Appropriate	40CFR125.100 40CFR125.104	1, 2, 3, 4, 6, 7, 8, 9
On-Site Land Disposal	Public Dose < 25 mrem/yr (Thyroid < 75 mrem/yr) Protection for Intruder Follow 10CFR20 Regulations Long-Term Stability Technical Requirements	Relevant and Appropriate	10CFR61, Subparts C,D 10CFR61.50-61.56	3, 6, 8

Chem, Action, Loc	Standard	ARAR/TBC	Regulation	Alternative
Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials	Limits Above Background: Ra-226 < 5 pCi/g per 100 sq.m. (avg over first 15 cm of soil) Ra-226 < 15 pCi/g per 100 sq.m. (15 cm thick layer < 15 cm deep) Annual Rn Decay Product < .02 WL Gamma Radiation < 20 uR/hr	Relevant and Appropriate	40CFR192, Subparts B,C	1, 2, 3, 4, 6, 7, 8, 9
On-Site, Solid, Nonhazardous, Waste Management Facilities	Waste Handling Plan Determine Excluded Wastes	Relevant and Appropriate	40CFR241.200-241.201	3, 5, 6, 8
Solid, Nonhazardous Waste Treatment and Disposal Facility Design Considerations	Design Plan Requirements Water Quality Air Quality Cover Material Compaction Safety	Relevant and Appropriate	40CFR241.202 40CFR241.204-241.205 40CFR241.209 40CFR241.211 ORC6111.45 OAC3745-27-06	3, 5, 6, 8
Treatment (in a Unit)	Design and Operating Standards	Relevant and Appropriate	40CFR264, Subparts J-L 40CFR264, Subpart X OAC3745-56-50 to 60 OAC3745-56-70 to 83 OAC3745-66-97 OAC3745-67-28 OAC3745-67-58 OAC3745-68-10 OAC3745-69-04	2, 6, 7, 8, 9
Closure with No Post-Closure Care	Criteria	Relevant and Appropriate	40CFR264.111 40CFR264.114 40CFR264.258 OAC3745-66-11,14	3, 4, 6, 7, 8, 9

Chem, Action, Loc	Standard	ARAR/TBC	Regulation	Alternative
Closure with Waste In-Place	Care must run > 30 years Follow 40CFR264.117-120 Follow 40CFR264, Subpart F	Relevant and Appropriate	40CFR264.117 40CFR264.310(b) OAC3745-66-17-20 OAC3745-66-11	1, 2, 3, 6, 8
Container Storage	Criteria	Relevant and Appropriate	40CFR264.171-264.178 40CFR268.5 OAC3745-55-70 to 78	1, 2, 3, 4, 6, 7, 8, 9
Construction of New Landfill On-Site	Minimum Technology Groundwater Monitoring	Relevant and Appropriate	40CFR264.301 40CFR264, Subpart F	3, 6, 8
Capping	Design and Construction	Relevant and Appropriate	40CFR264.310(a) OAC3745-66-11	1, 2, 3, 6, 8
Slurry Wall	Contamination	Relevant and Appropriate	40CFR268, Subpart D	1, 2
Placement of Waste in New Land Disposal Unit	Land Disposal Restrictions	Relevant and Appropriate	40CFR268, Subpart D	3, 6, 8
Wastewater Treatment	Permitting Requirements	Relevant and Appropriate	ORC6111.44 OAC3745-31	1, 2, 3, 4, 6, 7, 8, 9
Residual Radioactive Material in Soil	Limits Above Background (avg over 100 sq.m.) (Ra-226, Ra-228, Th-230, Th-232) < 5 pCi/g (first 15 cm of soil) < 15 pCi/g (15 cm thick layers) Other Radionuclides < 100 mrem/yr "Hot Spot" Criteria Calculation Guidelines	To Be Considered	DOE Order 5400.5, Chapter IV	1, 2, 3, 4, 6, 7, 8, 9

Chem, Action, Loc	Standard	ARAR/TBC	Regulation	Alternative
Residual Radioactive Material as Surface Contamination	Guidelines	To Be Considered	DOE Order 5400.5, Chapter IV	All
Land Disposal On-Site	Management	To Be Considered	DOE Order 5820.2A, Chapter III	1, 2, 3, 4, 6, 7, 8, 9
Land Disposal On-Site	Follow 40CFR192	To Be Considered	DOE Order 5820.2A, Chapter IV	1, 2, 3, 4, 6, 7, 8, 9

Operable Unit 4 Remedial Action Objectives

1. Radiation Doses:	Prevent current and future above-background radiation doses to the public from all pathways and all radionuclides (other than radon) from exceeding twenty-five percent of the 100 mrem annual dose limit.
2. Radon Emissions:	Prevent current and future radon-222 flux from a source from exceeding 20 $pCi/m^2/s$.
3. Radionuclide Air Emissions (Excluding Radon):	Prevent current and future above-background radiation doses to the public from airborne radionuclides (other than radon) from exceeding twenty-five percent of the 10 mrem/year annual air dose limit.

Operable Unit 4 Remedial Action Objectives (Continued)

4. Groundwater:	Prevent contamination of the groundwater from reaching twenty-five percent of a 4 mrem above-background annual dose limit for radionuclides and Maximum Contaminant Levels (MCLs), proposed MCLs, or risk-based (RfD) derived cleanup levels for non-radioactive hazardous materials.

Operable Unit 4
Groundwater Remedial Action Objectives

Constituent Metals	Basis for Remedial Objective	Acceptable Water Concentration (mg/L)	FMPC Remedial Action Level Per Operable Unit* (mg/L)
Arsenic	0.05 mg/L MCL	0.05	0.01
Barium	5.0 mg/L PMCL	5.0	1
Beryllium	0.005 mg/kg/d RfD	0.2	0.05
Cadmium	0.005 mg/L PMCL	0.005	0.001
Chromium	0.1 mg/L PMCL	0.1	0.03
Cobalt	---	---	---
Copper	1.3 mg/L HA #	1.3	0.3
Lead	0.05 mg/L MCL @	0.05	0.01
Manganese	0.2 mg/kg/d RfD	7.0	2
Selenium	0.003 mg/kg/d RfD	0.1	0.03
Silver	---	---	---
Thallium	0.00007 mg/kg/d RfD	0.002	0.0006
Vanadium	0.007 mg/kg/d RfD	0.2	0.06
Zinc	0.2 mg/kg/d RfD	7.0	2

* - Twenty-five percent of ARAR or risk-based standard.
@ - EPA is considering a substantially lower limit.
# - Health Advisory

Operable Unit 4
Groundwater Remedial Action Objectives

Constituent Radionuclides	Drinking Water Concentration Corresponding to 4 mrem/yr (pCi/l)	FMPC Action Level for a Single Operable Unit* (pCi/l)
U-234	19	5
U-235	21	5
U-238	21	5
Ra-224	15	4
Ra-226	4	1
Ra-228	4	1
Th-228	14	3
Th-230	10	2
Th-232	2	0.5
Pa-231	0.5	0.1
Po-210	3	0.7
Pb-210	1	0.2
Ac-227	0.4	0.1

* - Twenty-five percent of the drinking water concentration corresponding to 4 mrem/year

For multiple radionuclides in drinking water, the sum of the ratios of concentrations to action levels cannot exceed unity.

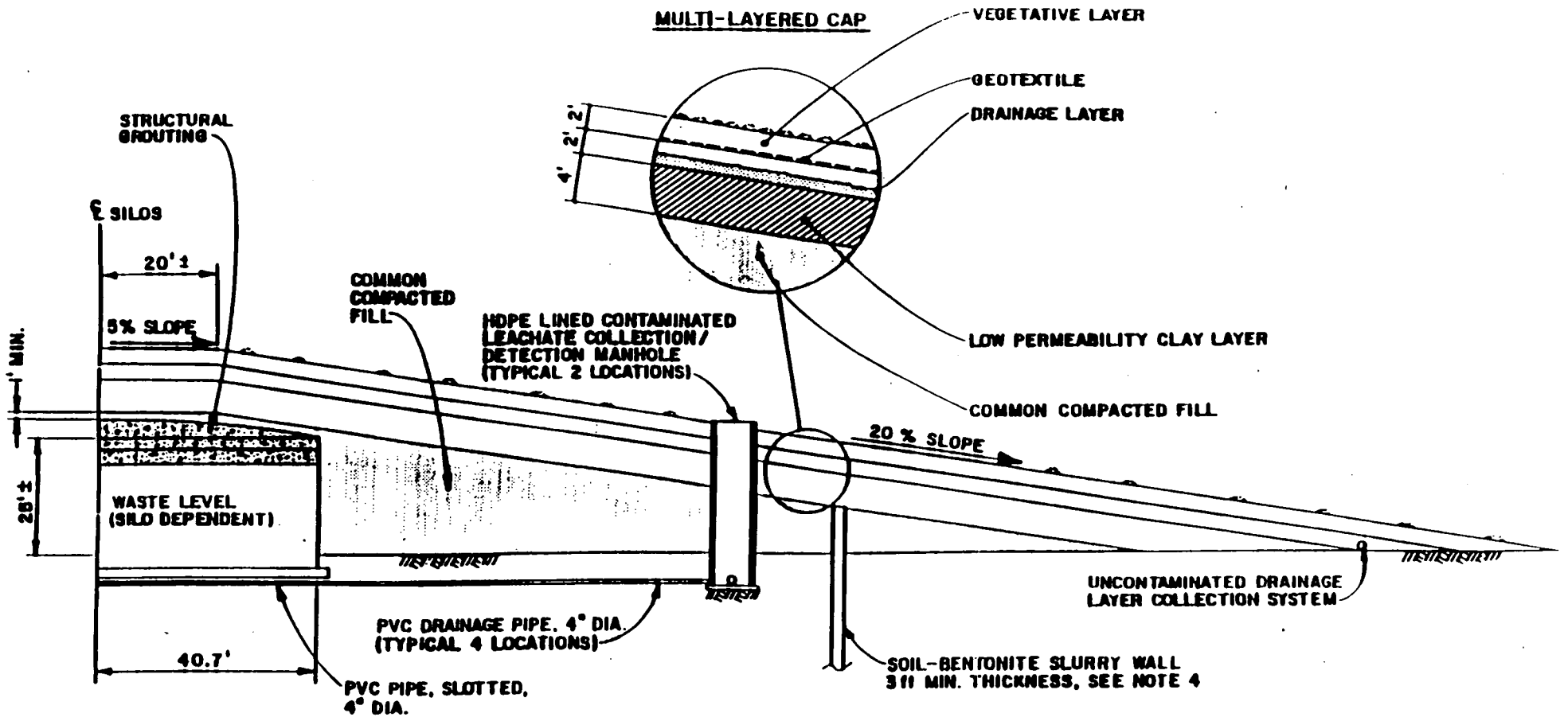
DESCRIPTIONS OF THE ALTERNATIVES

ALTERNATIVE 1
NONREMOVAL, SILO ISOLATION
SILOS 1, 2 & 3

- Fill Silo Void Space With Grout
- Install Slurry Wall to Isolate Silos from Groundwater
- Install Multilayer RCRA-Type Clay Cap Over All Three Silos to Intersect the Slurry Wall

ALTERNATIVE 1

- SILO VOID SPACE FILL
  - Structural Grout
  - Cap Support
  - Radon Barrier
- SLURRY WALL
  - 3/4 of the way around the silos
  - Soil-Bentonite mix.
  - Bentonite obtained off-site and mixed on-site.



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CAPPING PROFILE

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MULTILAYER CAP

- RADON BARRIER
  - Will consist of:
  - Upper vegetative layer
  - Drainage layer (Sand/Gravel)
  - Low permeability bottom layer (clay with 1 x 10E-7 cm/s permeability)
  - 5 meter rule
- CONTROL EROSION
- PREVENT RAIN WATER INFILTRATION
- CAP DESIGNED TO MEET 200 YEAR LIFE GOAL

ALTERNATIVE 2
NON REMOVAL - IN SITU STABILIZATION
SILOS 1, 2 & 3

- Identical to Alternative 1 Except Wastes are Stabilized In Situ

- Environmental Isolation Enclosure (EIE) Over Silos to Isolate Remediation Activities from Workers, Public, & Environment

- Silo Domes Removed Inside EIE

- Stabilization In Situ by Shallow Soil Mixing

ALTERNATIVE 2 (continued)

ENVIRONMENTAL ISOLATION ENCLOSURE

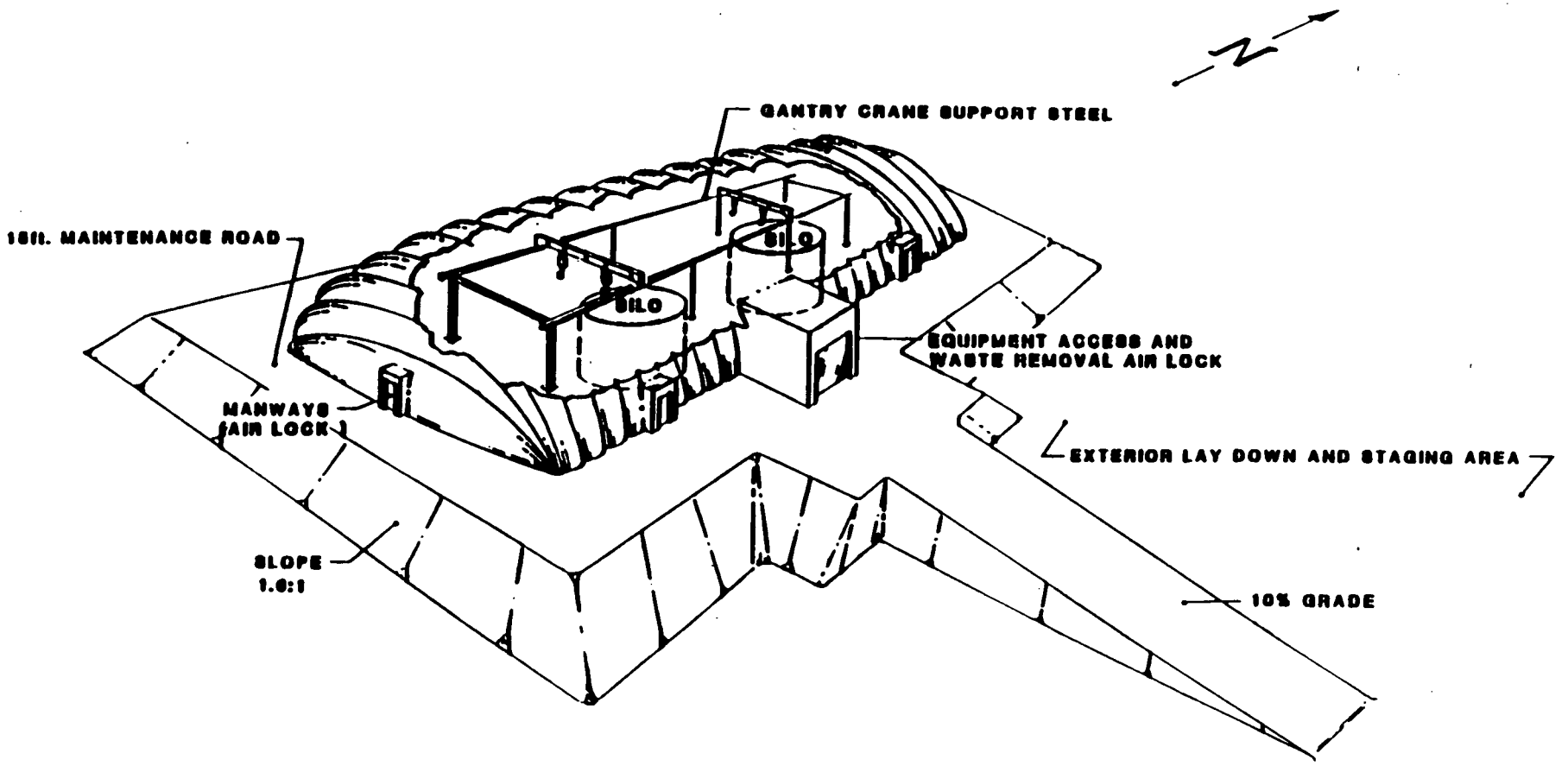
- Encloses the Silos and Surrounding Area, Isolating Remediation Activities from Workers, Public, and Environment

- Tension Arch Structure

- Negative Internal Pressure

- EIE Will Require/Possess the Following:

  - Silo berm modifications
  - HVAC system including air treatment (particulate and radon)
  - Central control station
  - Remote controlled travelling bridge crane



CONCEPTUAL VIEW OF ENVIRONMENTAL ISOLATION ENCLOSURE (EIE) OVER K-65 SILOS

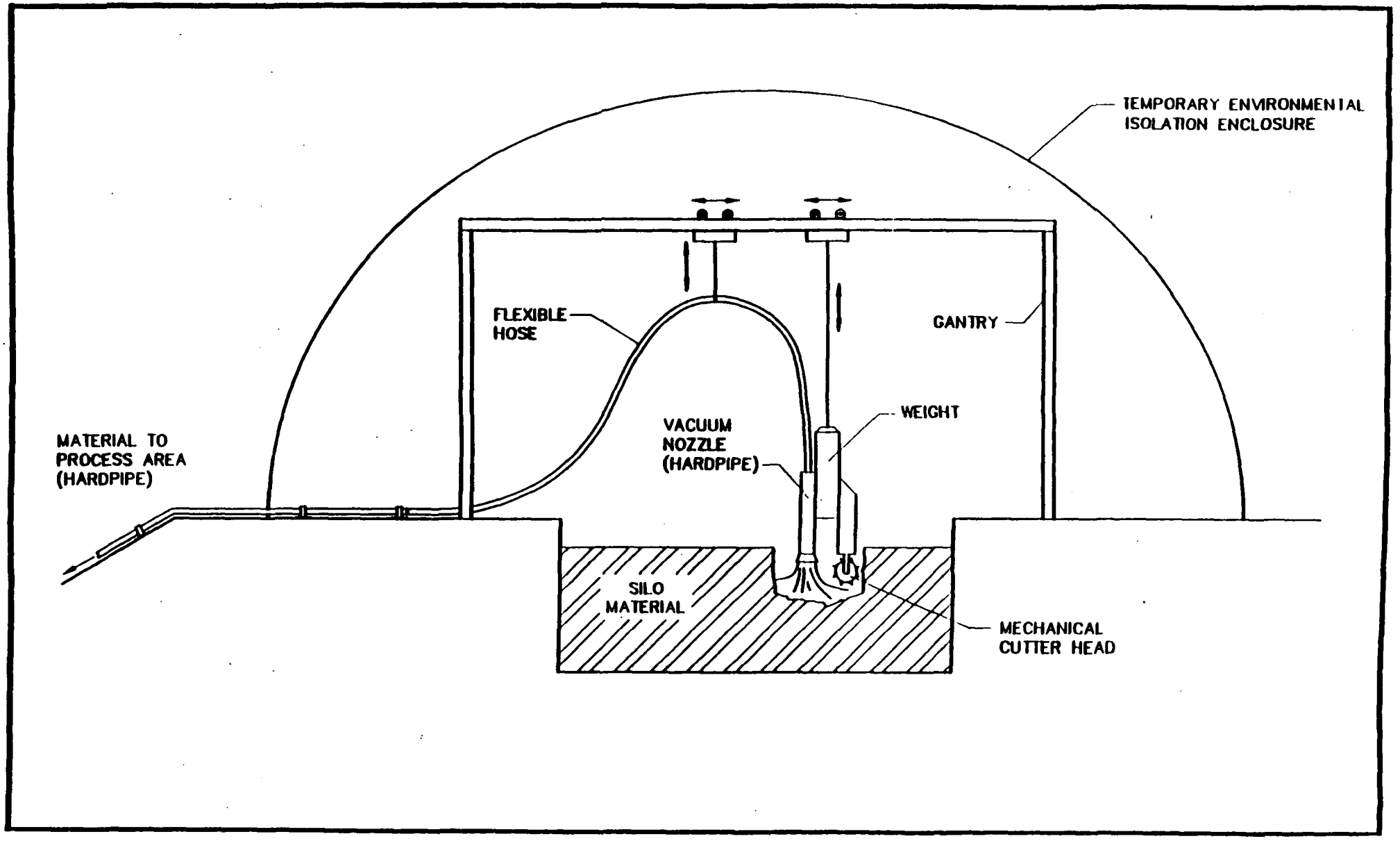
(3)

ALTERNATIVE 2

- SILO DOME REMOVAL
  - Mechanical removal remotely operated Gantry Crane
- IN-SITU STABILIZATION (SHALLOW SOIL MIXING)
  - Stabilizing agents into wastes by augers lowered into the silo from the Gantry Crane.
  - Volume increase of 30% may require raising the berms to balance the silo wall stress

ALTERNATIVES 3 & 4
REMOVE, PACKAGE, ON/OFF-SITE DISPOSAL
SILO 3 ONLY

- Alternative 4 Is Identical to Alternative 3 with the Exception of Off-Site Disposal
- EIE and Waste Packaging Building
- Remove Dome, Pneumatic Waste Removal
- Waste and Silo Debris Packaged for Final Disposal
- Disposal in On-Site Tumulus/Disposal Vault (Alternative 3)
- Transportation to Off-Site Disposal Facility (Alternative 4)

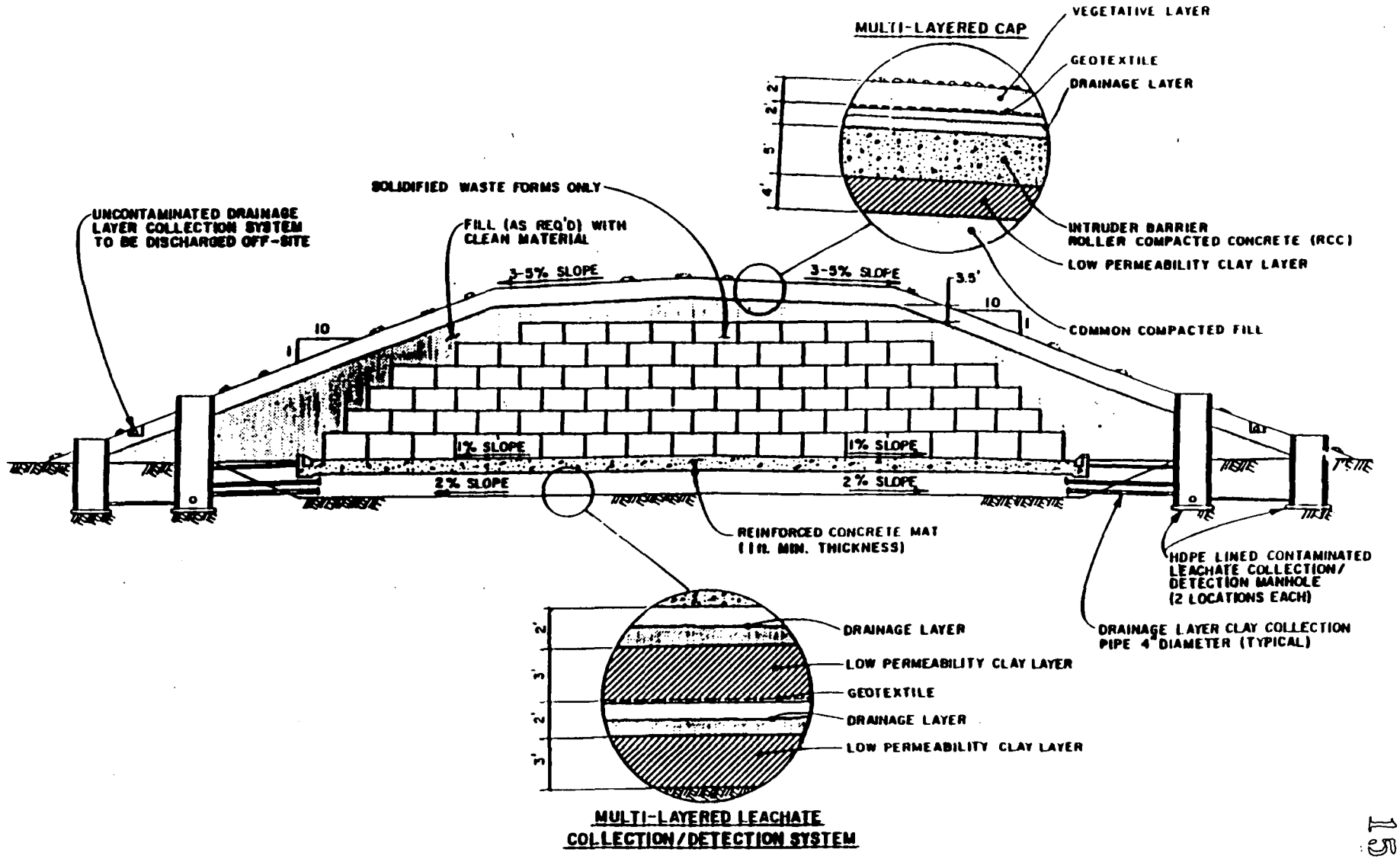


PNEUMATIC REMOVAL SYSTEM - GENERAL ARRANGEMENT

ALTERNATIVE 3 (continued)

TUMULUS

- Concrete Structural Pad
- Leachate Collection System
- Impermeable Liner Underlayment
- Impermeable Clay Cap
- Stabilized Waste Only (Structurally Rigid, Noncorrosive Waste Containers)
- Twelve Acres



MULTI-LAYERED LEACHATE COLLECTION/DETECTION SYSTEM

NOT TO SCALE

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TUMULUS SECTION

(10)

ALTERNATIVES 6 & 7
REMOVAL, TREATMENT, ON/OFF-SITE DISPOSAL
SILOS 1 AND 2

- Alternative 7 is Identical to Alternative 6 with Exception of Off-Site Disposal

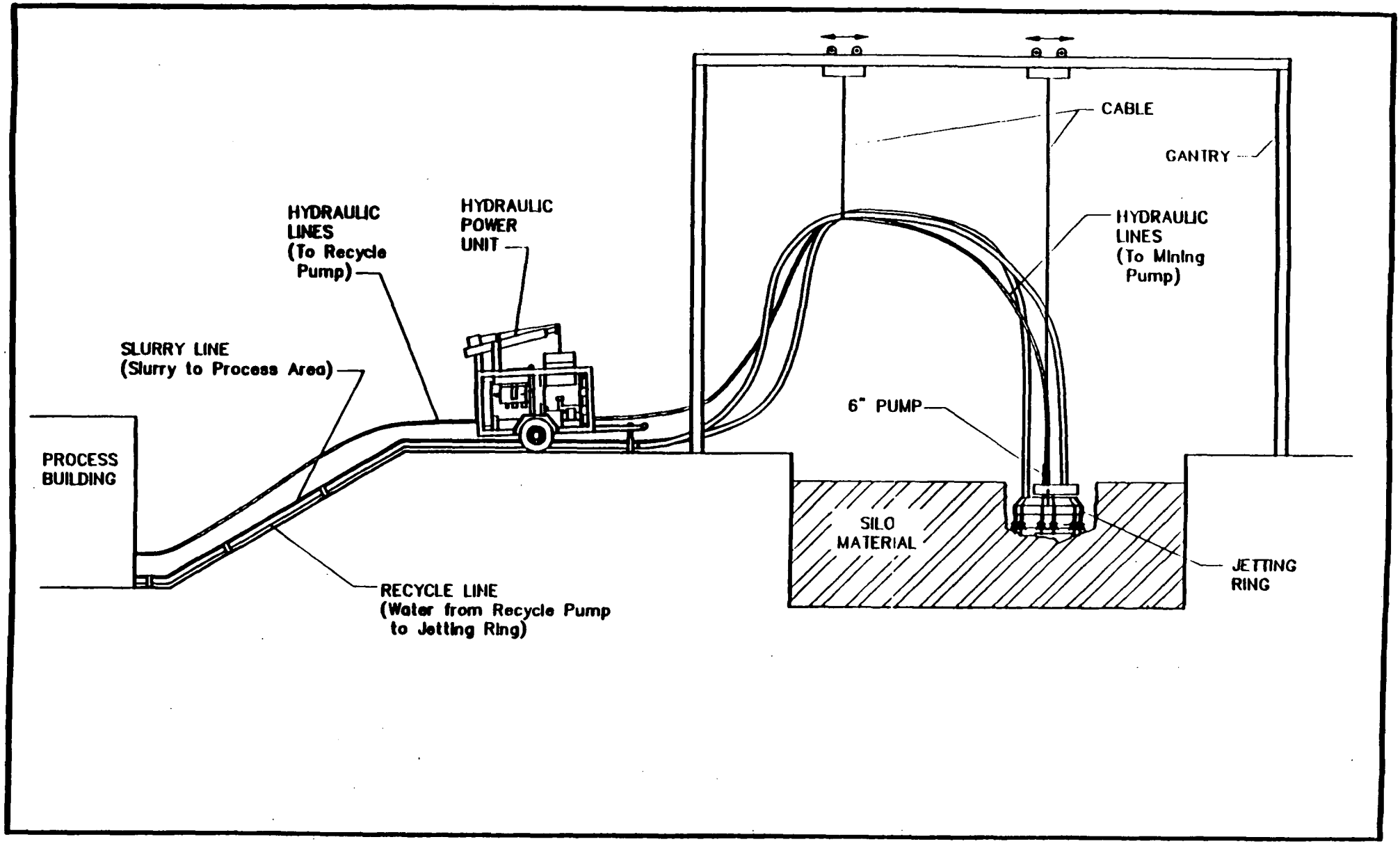
- EIE, Waste Processing, and Packaging Building

- Dome Removal

- Hydraulic Removal

HYDRAULIC REMOVAL

- Water Addded to Achieve Slurry Consistency
- Slurry Removed By Suction Line Connected to Combination Blasting/Suction Hydraulic Mining Tool
- Slurry Pumped to Solid/Liquid Separation System
- Sized to Remove 2 cu.ft./min.



HYDRUALIC MINING SYSTEM - GENERAL ARRANGEMENT

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ALTERNATIVES 6 & 7 (continued)

- Physical Stabilization or Vitrification
- Waste and Debris Packaging for On-Site or Off-Site Disposal
- Tumulus Construction (Alternative 6)
- Transportation to Off-Site Disposal Facility (Alternative 7)

ALTERNATIVES 8 & 9
REMOVAL, TREATMENT, ON/OFF-SITE DISPOSAL
SILOS 1 AND 2

- Alternative 9 is Identical to Alternative 8 with Exception of Off-Site Disposal
- EIE, Waste Processing, and Packaging Building
- Dome Removal
- Hydraulic Removal
- Contaminant Separation

ALTERNATIVES 8 & 9 (continued)

CONTAMINANT SEPARATION

LITERATURE REFERENCES

- Seely, 1977, ORNL ... 3 stage, 3M nitric acid leach removes 95% of radium and 98-99% of uranium & thorium from uranium mill tailings

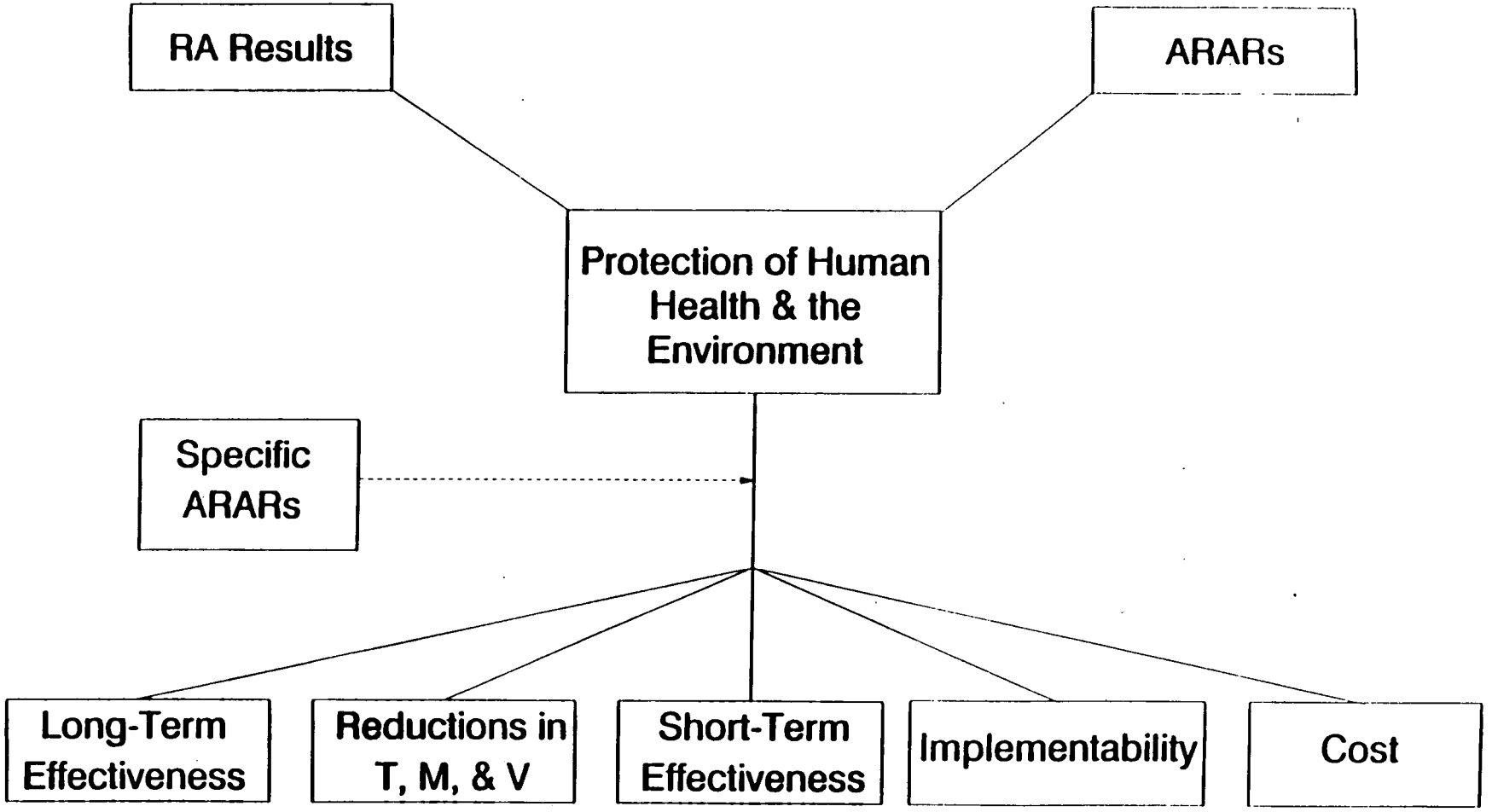
- Mound Laboratories, 1951, ... removed lead, radium & barium from K-65 material. Uranium & thorium were not mentioned

- Battelle, 1981 ... Oak Ridge.. proposed 6 stage nitric acid leach... dissolving both radium and uranium... while not thoroughly investigated... the nitric acid leaching should be considered in designing a process...

ALTERNATIVES 8 & 9 (continued)

- Physical Stabilization or Vitrification
- Waste and Debris Packaging for On-Site or Off-Site Disposal
- Tumulus Construction (Alternative 8)
- Transportation to Off-Site Disposal Facility (Alternative 9)

EVALUATION OF ALTERNATIVES VS. CRITERIA


RA Results
ARARs
Protection of Human Health & the Environment
Specific ARARs
Long-Term Effectiveness
Reductions in T, M, & V
Short-Term Effectiveness
Implementability
Cost

COMPLIANCE WITH ARARs

Alternative 0

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Fails	- Violates Radon-222 Emmission Standards 40CFR61, Subpart Q - May not meet requirements for Chemicals and Radionuclides in Drinking Water 40CFR141.11,15,16

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 0

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Fails	1. ARARs Will Not Be Met 2. Remedial Actions Objectives Will Not BE Met

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 0

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Fails	1. No Material Treated or Isolated
2. Adequacy and Reliability of Controls	Fails	2. No Monitoring in Place No Leachate Collection

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 0

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Fails	1. Waste Not Treated
2. Amount of Hazardous Materials Destroyed or Treated	Fails	2. Waste Not Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Fails	3. Waste Not Treated
4. Degree to which Treatment is Irreversible	Fails	4. Waste Not Treated
5. Type and Quantity of Residuals Remaining After Treatment	Fails	5. Waste In-Place and Unchanged

SHORT-TERM EFFECTIVENESS

Alternative 0

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Fails	1. No Attenuation of Radon and No Control of Leaching to Groundwater
2. Protection of Workers During Remedial Actions	N/A	2. No Remedial Action is Conducted
3. Environmental Impacts	Meets	3. No Remedial Action is Conducted
4. Time Until Remedial Action Objectives are Achieved	N/A	

IMPLEMENTABILITY

Alternative 0

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. No Construction or Operation are Involved
2. Reliability of the Technology	N/A	
3. Ease of Undertaking Additional Remedial Action, If Necessary	Meets	3. No Change is Made
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	N/A	
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 0

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	N/A	8. None Needed
9. Availability of Prospective Technologies	N/A	9. No Technologies Required

COMPLIANCE WITH ARARs

Alternative 1

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Unknown	- May not meet requirements for Chemicals and Radionuclides in Drinking Water 40CFR141.11,15,16

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 1

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Unknown	1. ARARs May Not Be Met

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Unknown	1. ARARs May Not be Met
2. Adequacy and Reliability of Controls	Meets	2. Inspection, Leachate Detection and Groundwater Sampling

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 1

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Fails	1. Waste Not Treated
2. Amount of Hazardous Materials Destroyed or Treated	Fails	2. Waste Not Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Fails	3. Waste Not Treated
4. Degree to which Treatment is Irreversible	Fails	4. Waste Not Treated
5. Type and Quantity of Residuals Remaining After Treatment	Fails	5. Waste In-Place and Unchanged

SHORT-TERM EFFECTIVENESS

Alternative 1

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. Radon Removal System Limits Releases During Grouting
2. Protection of Workers During Remedial Actions	Meets	2. Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Paddy's Run Must be Relocated
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 27 Months

IMPLEMENTABILITY

Alternative 1

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Caps and Slurry Walls are Routinely Constructed
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	Meets	3. Layers Easily Added To Cap
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	Meets	6. Part of Approval Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 1

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available

COMPLIANCE WITH ARARs

Alternative 2

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Unknown	- May not meet requirements for Chemicals and Radionuclides in Drinking Water 40CFR141.11,15,16

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 2

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Unknown	1. ARARs May Not Be Met

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 2

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Unknown	1. ARARs May Not Be Met
2. Adequacy and Reliability of Controls	Meets	2. Inspection, Leachate Detection and Groundwater Sampling

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 2

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Meets	1. In-Situ Stabilization
2. Amount of Hazardous Materials Destroyed or Treated	Meets	2. Majority of Waste Stabilized
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Meets	3. Mobility Reduced
4. Degree to which Treatment is Irreversible	Meets	4. Reversibility minimized with Treatment and Cap Maintenance
5. Type and Quantity of Residuals Remaining After Treatment	Unknown	5. Any Waste Which May Have Migrated Will Not Be Treated

SHORT-TERM EFFECTIVENESS

Alternative 2

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. Environmental Isolation Enclosure (EIE) Isolates Waste
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Paddy's Run Must be Relocated
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 36 months

IMPLEMENTABILITY

Alternative 2

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Shallow Soil Mixing, Cap and Slurry Wall Proven Technologies
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	Meets	3. Layers Easily Added To Cap
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	Meets	6. Part of Approval Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 2

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available

COMPLIANCE WITH ARARs

Alternative 3

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 3

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	- Waste Removed from Silo - Operations Conducted in Controlled Environments - Waste Packaged in Approved Containers - Containers Stored in Tumulus

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 3

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Waste Placed in Tumulus
2. Adequacy and Reliability of Controls	Meets	2. Inspection, Leachate Detection and Groundwater Sampling

REDUCTION OF TOXICITY,
MOBILITY, OR VOLUME
THROUGH TREATMENT

Alternative 3

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Fails	1. Waste Not Treated
2. Amount of Hazardous Materials Destroyed or Treated	Fails	2. Waste Not Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Fails	3. Waste Not Treated
4. Degree to which Treatment is Irreversible	Fails	4. Waste Not Treated
5. Type and Quantity of Residuals Remaining After Treatment	Fails	5. Waste Remains In-Place

SHORT-TERM EFFECTIVENESS

Alternative 3

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. Environmental Isolation Enclosure (EIE) Isolates Waste From Community
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Construction of Tumulus May Impact Environment
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 27 Months

IMPLEMENTABILITY

Alternative 3

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Removal, Packaging, and Tumulus Technology Proven
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	Possible	3. Layers Easily Added To Tumulus Material Could be Retrieved
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	Meets	6. Part of Required Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 3

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available

COMPLIANCE WITH ARARs

Alternative 4

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 4

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	-Waste Removed from Site

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 4

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Off-Site Disposal Eliminates Risks
2. Adequacy and Reliability of Controls	N/A	2. No Controls Required

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 4

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Fails	1. Waste Not Treated
2. Amount of Hazardous Materials Destroyed or Treated	Fails	2. Waste Not Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Fails	3. Waste Not Treated
4. Degree to which Treatment is Irreversible	Fails	4. Waste Not Treated
5. Type and Quantity of Residuals Remaining After Treatment	Meets	5. Waste Not Treated but Shipped Off-Site

SHORT-TERM EFFECTIVENESS

Alternative 4

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. EIE During Removal and Packaging. Small Risk Associated with Off-Site Transport
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Meets	3. Minimal Impacts Expected
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 27 Months

IMPLEMENTABILITY

Alternative 4

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Removal and Packaging Technologies Proven
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	N/A	3. No Waste On-Site
4. Ability to Monitor Effectiveness of Remedy	N/A	4. No Waste On-Site
5. Ability to Obtain Approvals From Other Agencies	Unknown	
6. Coordination with Other Agencies	Meets	6. DOT Requirements Will be Met
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	Unknown	7. No Site Can Currently Accept Waste

IMPLEMENTABILITY
(cont.)

Alternative 4

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available

COMPLIANCE WITH ARARs

Alternative 6

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 6

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	- Waste Removed from Silos 1 and 2 - Operations Conducted in Controlled Environments - Waste Solidified and Packaged in Containers - Containers Stored in Tumulus

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 6

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Waste Treated and Placed in Tumulus
2. Adequacy and Reliability of Controls	Meets	2. Inspection, Leachate Detection and Groundwater Sampling

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 6

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Meets	1. Stabilization or Vitrification
2. Amount of Hazardous Materials Destroyed or Treated	Meets	2. All Waste Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Meets	3. Mobility Reduced
4. Degree to which Treatment is Irreversible	Meets	4. Highly Irreversible
5. Type and Quantity of Residuals Remaining After Treatment	Meets	5. All Waste Treated

SHORT-TERM EFFECTIVENESS

Alternative 6

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. EIE Isolates Waste from Community
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Construction of Tumulus May Impact Environment
4. Time Until Remedial Action Objectives are Achieved	N/A	4. Stabilization - 32 Months Vitrification - 58 Months

IMPLEMENTABILITY

Alternative 6

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Removal, Stabilization, and Vitrification Technologies Proven Treatability Required For This material
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	Meets	3. Layers Easily Added To Tumulus
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	Meets	6. Required Part of Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 6

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available Treatability Required

COMPLIANCE WITH ARARs

Alternative 7

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 7

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	- Waste Removed from Site

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 7

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Off-Site Disposal Eliminates Risks
2. Adequacy and Reliability of Controls	N/A	2. No Controls Required

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 7

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Meets	1. Stabilization or Vitrification
2. Amount of Hazardous Materials Destroyed or Treated	Meets	2. All Waste Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Meets	3. Mobility Reduced
4. Degree to which Treatment is Irreversible	Meets	4. Highly Irreversible
5. Type and Quantity of Residuals Remaining After Treatment	Meets	5. All Waste Treated

SHORT-TERM EFFECTIVENESS

Alternative 7

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. EIE Isolates Waste. Small Risk Associated with Off-Site Transport
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Meets	3. Minimal Impacts Expected
4. Time Until Remedial Action Objectives are Achieved	N/A	4. Stabilization - 32 Months Vitrification - 58 Months

IMPLEMENTABILITY

Alternative 7

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Removal, Stabilization, and Vitrification Technologies Proven Treatability Required
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	N/A	3. No Waste On-Site
4. Ability to Monitor Effectiveness of Remedy	N/A	4. No Waste On-Site
5. Ability to Obtain Approvals From Other Agencies	Unknown	
6. Coordination with Other Agencies	Meets	6. Part of Approval Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	Unknown	7. No Site Can Currently Accept Waste

IMPLEMENTABILITY
(cont.)

Alternative 7

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available Treatability Required

COMPLIANCE WITH ARARs

Alternative 8

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 8

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	- Waste Removed from Silos 1 and 2 - Operations Conducted in Controlled Environments - Waste Solidified and Packaged in Containers - Containers Stored in Tumulus

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 8

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Waste Treated and Placed in Tumulus
2. Adequacy and Reliability of Controls	Meets	2. Inspection, Leachate Detection and Groundwater Sampling

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 8

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Meets	1. Acid Leaching Followed By Stabilization or Vitrification
2. Amount of Hazardous Materials Destroyed or Treated	Meets	2. All Waste Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Meets	3. Mobility and Volume Reduced
4. Degree to which Treatment is Irreversible	Meets	4. Highly Irreversible
5. Type and Quantity of Residuals Remaining After Treatment	Meets	5. All Waste Treated

SHORT-TERM EFFECTIVENESS

Alternative 8

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. EIE Isolates Waste from Community
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Construction of Tumulus May Impact Environment
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 33 Months

IMPLEMENTABILITY

Alternative 8

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Technologies Proven but Treatability Required
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	Meets	3. Layers Easily Added To Tumulus
4. Ability to Monitor Effectiveness of Remedy	Meets	4. Visual Inspection, Leachate Detection, and Groundwater Sampling
5. Ability to Obtain Approvals From Other Agencies	N/A	
6. Coordination with Other Agencies	Meets	6. Part of Approval Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	N/A	

IMPLEMENTABILITY
(cont.)

Alternative 8

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available Treatability Required

COMPLIANCE WITH ARARs

Alternative 9

Subcriteria	Meets/Fails	Reason
1. Compliance with ARARs	Meets	- All ARARs will be met

OVERALL PROTECTION OF HEALTH AND THE ENVIRONMENT

Alternative 9

Subcriteria	Meets/Fails	Reason
1. How Alternative Provides Human Health and Environmental Protection	Meets	- Waste Removed from Site

LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 9

Subcriteria	Meets/Fails	Reason
1. Magnitude of Residual Risks	Meets	1. Off-Site Disposal Eliminates Risks
2. Adequacy and Reliability of Controls	N/A	2. No Controls Required

REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative 9

Subcriteria	Meets/Fails	Reason
1. Treatment Process Used and Materials Treated	Meets	1. Acid Leaching Followed By Stabilization or Vitrification
2. Amount of Hazardous Materials Destroyed or Treated	Meets	2. All Waste Treated
3. Degree of Expected Reductions in Toxicity, Mobility, or Volume	Meets	3. Mobility and Volume Reduced
4. Degree to which Treatment is Irreversible	Meets	4. Highly Irreversible
5. Type and Quantity of Residuals Remaining After Treatment	Meets	5. All Waste Treated and Shipped Off-Site

SHORT-TERM EFFECTIVENESS

Alternative 9

Subcriteria	Meets/Fails	Reason
1. Protection of Community	Meets	1. EIE Isolates Waste. Small Risk Associated with Off-Site Transport
2. Protection of Workers During Remedial Actions	Meets	2. EIE and Health and Safety Measures Utilized
3. Environmental Impacts	Unknown	3. Minimal Effects Expected
4. Time Until Remedial Action Objectives are Achieved	N/A	4. 32 Months

IMPLEMENTABILITY

Alternative 9

Subcriteria	Meets/Fails	Reason
1. Ability to Construct and Operate the the Technology	Meets	1. Technologies Proven but Treatability Required
2. Reliability of the Technology	Meets	2. No Technical Delays Anticipated
3. Ease of Undertaking Additional Remedial Action, If Necessary	N/A	3. No Waste On-Site
4. Ability to Monitor Effectiveness of Remedy	N/A	4. No Waste On-Site
5. Ability to Obtain Approvals From Other Agencies	Unknown	
6. Coordination with Other Agencies	Meets	6. Part of Approval Process
7. Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	Unknown	7. No Site Can Currently Accept Waste

IMPLEMENTABILITY
(cont.)

Alternative 9

Subcriteria	Meets/Fails	Reason
8. Availability of Necessary Equipment and Specialists	Meets	8. Equipment and Specialists Readily Available
9. Availability of Prospective Technologies	Meets	9. Technologies Readily Available Treatability Required

EVALUATION OF ALTERNATIVES VS. CRITERIA

COST

Alternative 1: NONREMOVAL, SILO ISOLATION-SILOS 1, 2, 3

Alternative 2: NONREMOVAL, IN SITU STABILIZATION AND CAP-SILOS 1, 2, 3

Alternative 3: REMOVAL AND ON-SITE DISPOSAL-SILO 3

Alternative 3B: (APPORTIONED SITE-WIDE TUMULUS)

Alternative 4: REMOVAL AND OFF-SITE DISPOSAL-SILO 3

Alternative 6: REMOVAL, TREATMENT, & ON-SITE DISPOSAL-SILOS 1, 2

Alternative 6B: (APPORTIONED SITE-WIDE TUMULUS)

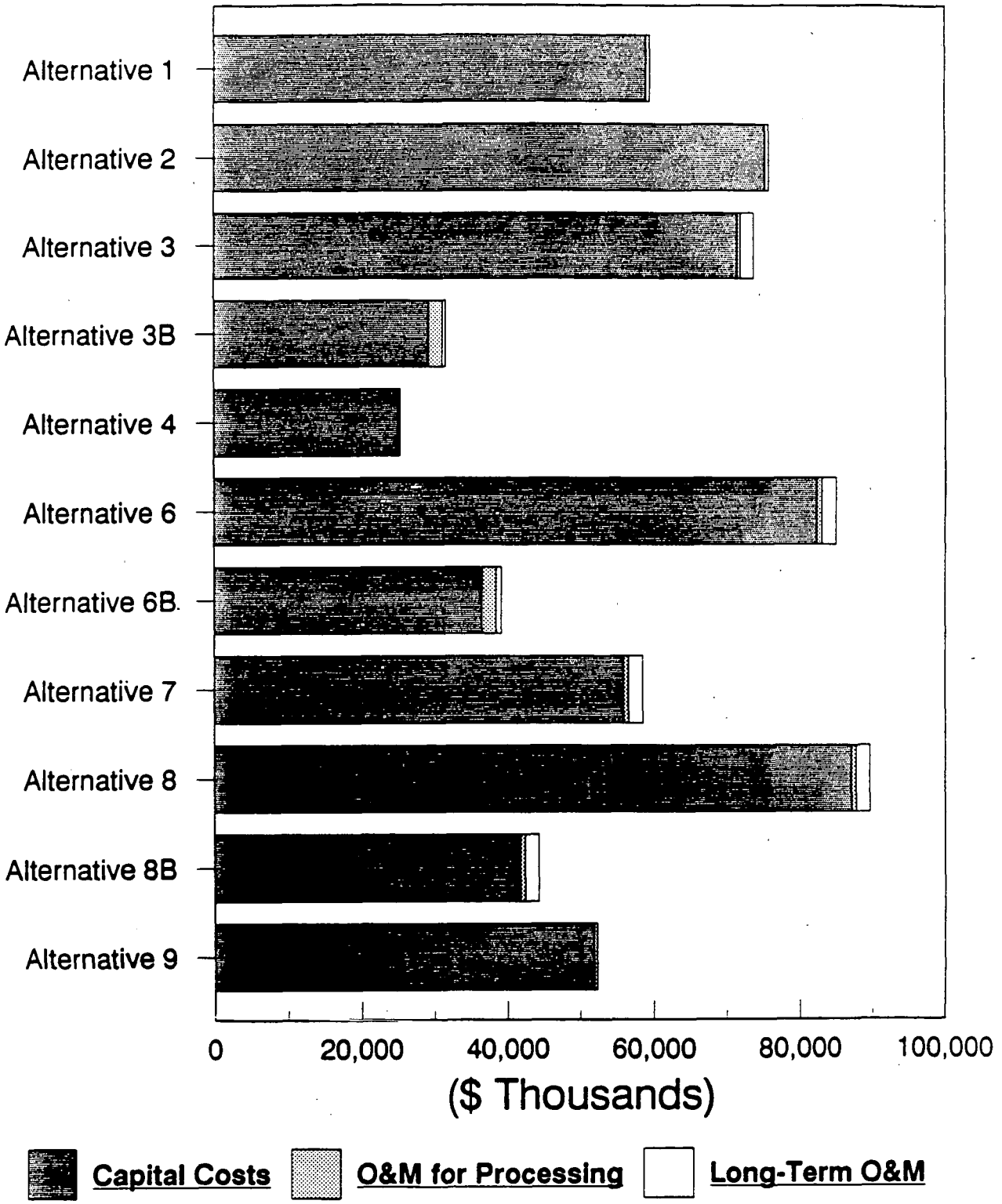
Alternative 7: REMOVAL, TREATMENT, & OFF-SITE DISPOSAL-SILOS 1, 2

Alternative 8: REMOVAL, SEPARATION, & ON-SITE DISPOSAL-SILOS 1, 2

Alternative 8B: (APPORTIONED SITE-WIDE TUMULUS)

Alternative 9: REMOVAL, SEPARATION, & OFF-SITE DISPOSAL-SILOS 1, 2

OPERABLE UNIT 4
COST COMPARISON OF ALTERNATIVES



RESULTS OF TASK-13

- Alternatives 1-4 and 6-9 analyzed in detail
- Assumptions made to allow continuation o task while awaiting more data
- Preliminary ARARs identified
- Eight alternatives carried into Task-14
  - Four on-site options for K-65
  - Two off-site options for K-65
  - Three on-site options for Silo 3
  - One off-site option for Silo 3